

9. DRINKING WATER AND FOOD

The ingestion of contaminated food and water is a potential source of human exposure to toxic compounds. This section focuses on the available data for populations consuming water from specific sources, populations who breastfeed, and populations who consume certain foods.

9.1. POPULATION CONSUMING DRINKING WATER BY SOURCE OF WATER SUPPLY

The consumption of contaminated drinking water is a potential source of exposure to toxic compounds. Contaminants may be present in drinking water before, during, and after treatment. The majority of public water systems treat their water as necessary to ensure that the water is safe to drink. Contaminants may differ depending on the source of water supply (i.e., surface water or groundwater).

EPA established a National Public Water Systems Supervision Program in 1974 under the authority of the Safe Drinking Water Act. Table 9-1 presents data for populations served from public water systems for 1994 (U.S. EPA, 1995). The table presents these data for the number of systems and the population served by community water systems, nontransient noncommunity water systems, and transient noncommunity water systems. The data also are presented by the source of water (i.e., ground or surface). Table 9-2 presents the same type of data for 1993 (U.S. EPA, 1994).

In 1994, a total of 186,822 water systems in 50 States, on Native American lands, and in U.S. territories were classified as public water systems. The largest percentage of the population is served by community water systems (Table 9-1).

9.2. POPULATION USING BOTTLED WATER

Through the National Human Activity Pattern Survey (NHAPS) (Tsang and Klepeis, 1996), information was collected for the general population on the duration and frequency of selected activities and the time spent in selected microenvironments via 24-hour diaries. More than 9,000 individuals from 48 contiguous States participated in NHAPS. The survey was

conducted between October 1992 and September 1994. Participants were selected using a Random Digit Dial (RDD) method and Computer Assisted Telephone Interviewing (CATI). Individuals were interviewed to categorize their 24-hour routines (diaries) and/or answer follow-up exposure questions related to exposure events. The response rate was 63 percent, overall. Data were collected for a maximum of 91 different activities based on selected socioeconomic (gender, age, race, education, etc.) and geographic (census region, State, etc.) factors and time/season (day of week, month) and weighted to ensure that results were representative of the U.S. population. The weighted sample matches the 1990 U.S. census population for each gender, age group, census region, and the day-of-week and seasonal responses are equally distributed (Tsang and Klepeis, 1996). As part of the survey, data also were collected for the source of water used in the household and for the population in the survey who used bottled water for drinking water. These data are presented in Tables 9-3 and 9-4.

9.3. POPULATION BREASTFEEDING

Breast milk is a potential source of exposure to toxic chemicals among nursing infants. Some chemical compounds accumulate in fatty tissues and may be transferred to breastfed infants in the lipid portion of breast milk. In many cases, nursing infants obtain most of their dietary caloric and fluid intakes from breast milk, thus they have high risk of exposure to contaminants in breast milk. Information on the volume of breast milk consumed over a period of time is required to estimate the potential breast milk contaminant dose in infants. (See *Exposure Factors Handbook* (U.S. EPA, 1997), Section 14.) In addition, identification of the population who breastfeeds is needed. The available data for the percentage of the population who breastfeeds are presented below.

The National Academy of Sciences (NAS) Institute of Medicine reviewed the published literature to determine the incidence of breastfeeding in the United States by different demographic characteristics. Statistics on breastfeeding in the United States were obtained from a 1989 survey entitled, "Nutrition During Lactation" (NAS, 1991).

Results from the survey (NAS, 1991) indicated that 52.2% of women who delivered babies in 1989 breastfed their newborn infants. The NAS report also revealed that 19.6% of these infants were still breastfed at the age of 5 to 6 months. The data presented in Table 9-5 show the percentage of mothers who breastfeed among whites, blacks, and Hispanics grouped by marital status, education, maternal age, employment, family income, and U.S. regions. The data show that of the three racial/ethnic groups, more white mothers breastfed infants (58.5%), while the lowest percentage were black mothers (23%), followed by Hispanic mothers at 48.4%. According to the data in Table 9-5, breastfeeding of newborns and at 5 to 6 months is directly related to family income (i.e., the higher the income, the higher the rate of breastfeeding in all three ethnic groups). The highest percentage of mothers who breastfeed were found in the Mountain and Pacific regions for all racial/ethnic groups. A conservative estimate for the breastfed population could be developed by applying these percentages to the number of live births in a year, assuming all of the live births will have a lifespan of at least 1 year. This estimate would capture breast-fed infants up to 12 months. The Bureau of Census provide vital statistics data by year, race, and location (State, Region) in the yearly statistical abstracts publications. Breast milk ingestion rates are presented in *Exposure Factors Handbook*, Section 13.

9.4. POPULATION CONSUMING SELECTED FOODS/FOOD GROUPS

Ingestion of contaminated foods is a pathway of human exposure to toxic chemicals. Fruits and vegetables and grain products may become contaminated, for example, from deposition of ambient pollutants in the air, irrigation waters, soil additives, pesticides, and fertilizers. Fish and shellfish may become contaminated from pollutants in the surface waters and sediments. Meat, poultry, and dairy products can become contaminated if the animals are exposed to contaminated media such as soil, water, or feed crops.

EPA analyzed 3 years (1989, 1990, and 1991) of data from the U.S. Department of Agriculture's Continuing Survey of Food Intakes by Individuals to generate distributions of intake rates for various (1) fruit and vegetable items/groups; (2) grain products; (3) meat, poultry, and dairy products; and (4) fish and shellfish. As part of this analysis, the percentages of populations consuming the various foods were estimated. These populations are presented with the

corresponding intake tables in the *Exposure Factors Handbook* (U.S. EPA, 1997). A discussion of how the analyses were performed and the caveats also are presented in the handbook in their respective sections. Information on various food groups can be found in the *Exposure Factors Handbook* (U.S. EPA, 1997) as follows:

- Fruits and vegetables: Section 9, Tables 9-3 to 9-11;
- Fish and shellfish: Section 10, Tables 10-7 to 10-44;
- Meat, poultry, and dairy products: Section 11, Tables 11-1 to 11-4;
- Grain products, Chapter 12, Tables 12-1 to 12-10; and
- Homeproduced food items: Section 13, Tables 13-8 to 13-70.

9.5. REFERENCES

National Academy of Sciences (NAS). (1991) Nutrition during lactation. National Academy of Sciences Institute of Medicine. Washington, DC: National Academy Press.

Tsang, AM; Klepeis, NE. (1996) Results tables from a detailed analysis of the National Human Activity Patterns Survey (NHAPS) response. Prepared by Lockheed Martin, for the U.S. Environmental Protection Agency, Washington, DC, under EPA contract no. 68-W6-001, delivery order no. 13. Draft report.

U.S. Environmental Protection Agency. (1994) The national public water systems supervision program. The FY 1993 compliance report. The Office of Water, Washington, DC; EPA 812-R-94-001.

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Table 9-1. Population Served by Public Water Systems (PWS) in the United States: 1994

Systems	Source				Total		Percent of Total PWS
	Surface Water		Ground Water				
CWS ^a							
No. of Systems	10,625	(19%)	46,122	(3%)	56,747	(100%)	30%
Population Served	152,491,000	(63%)	90,558,000	(37%)	243,049,000	(100%)	NA
NTNCWS ^b							
No. of Systems	766	(3%)	22,873	(97%)	23,639	(100%)	13%
Population Served	596,000	(10%)	5,645,000	(90%)	6,241,000	(100%)	NA
TNCWS ^c							
No. of Systems	2,099	(2%)	104,337	(98%)	106,436	(100%)	57%
Population Served	900,000	(7%)	12,709,000	(93%)	13,609,000	(100%)	NA
ALL PWS ^{d,e}							
No. of Systems	13,490	(7%)	173,332	(93%)	186,822	(100%)	100%

a CWS--Community water systems - Provides drinking water primarily to residential areas; provides water to the same population year round.

b NTNCWS--Nontransient noncommunity water systems. A PWS that regularly serves at least 25 of the same people at least 6 months of the year; includes places such as schools, factories, and hospitals that have their own water supplies.

c TNCWS--Transient noncommunity water systems. For transitory customers in nonresidential areas such as campgrounds, motels, and gas stations.

d Includes systems that obtain their drinking water from other PWS.

e Because an individual can be served by more than one category of PWS, the total population served by all PWS is not cumulative and therefore cannot be determined.

Note: NA = Not applicable.

(%) = Percent of total systems in that specific system category or percent of total population in a system category (i.e., 10,625 CWS is 19% of 56,747 total systems and 152,491,000 is 63% of total population served (243,049,000 people) by CWS.

Source: U.S. EPA, 1995.

Table 9-2. Population Served by Public Water Systems (PWS) in the United States: 1993

Systems	Source				Total		Percent of Total PWS
	Surface Water		Ground Water				
CWS ^a							
No. of Systems	10,681	(19%)	46,880	(81%)	56,561	(100%)	30%
Population Served	148,686,000	(61%)	93,995,000	(39%)	242,679,000	(100%)	NA
NTNCWS ^b							
No. of Systems	771	(3%)	23,221	(97%)	23,992	(100%)	13%
Population Served	625,000	(10%)	5,690,000	(90%)	6,315,000	(100%)	NA
TNCWS ^c							
No. of Systems	2,228	(29%)	104,488	(98%)	109,714	(100%)	57%
Population Served	1,157,000	(7%)	14,271,000	(93%)	15,428,000	(100%)	NA
ALL PWS ^{d,e}							
No. of Systems	13,678	(7%)	173,589	(93%)	191,267	(100%)	100%

a CWS--Community water systems. Provides drinking water primarily to residential areas; provides water to the same population year round.

b NTNCWS--Nontransient noncommunity water systems. A PWS that regularly serves at least 25 of the same people at least 6 months of the year; includes places such as schools, factories, and hospitals that have their own water supplies.

c TNCWS-Transient noncommunity water systems. For transitory customers in nonresidential areas such as campgrounds, motels and gas stations.

d Includes systems that obtain their drinking water from other PWS.

e Because an individual can be served by more than one category of PWS, the total population served by all PWS is not cumulative and therefore cannot be determined.

Note: NA = Not applicable.

(%) = Percent of total systems in that specific system category or percent of total population in a system category (i.e., 10,681 CWS is 19% of 56,561 total systems, and 148,686,000 is 61% of total population served (242,679,000 people) by CWS.

Source: U.S. EPA, 1994.

Table 9-3. Number of Respondents Who Obtained Water From Public and Private Water Sources for General Household Use

	Total N	Public Water	Private Well	Other Source	DK
Overall	4663	3777	719	121	46
Gender					
Male	2163	1747	338	62	16
Female	2498	2029	380	59	30
Refused	2	1	1	--	--
Age (years)					
--	84	73	7	4	--
1-4	263	211	38	12	2
5-11	348	285	52	6	5
12-17	326	251	68	5	2
18-64	2972	2411	461	71	29
> 64		670	546	93	23
Race / Ethnicity					
White	3774	2990	659	96	29
Black	463	410	29	14	10
Asian	77	72	2	2	1
Some other	96	85	7	2	2
Hispanic	193	172	13	5	3
Refused	60	48	9	2	1
Hispanic					
No	4244	3417	676	110	41
Yes	347	304	31	9	3
DK	26	18	6	1	1
Refused	46	38	6	1	1
Employment					
--	926	738	157	22	9
Full time	2017	1641	304	56	16
Part time	379	315	53	7	4
Not Employed	1309	1057	200	35	17
Refused	32	26	5	1	--
Education					
--	1021	812	174	26	9
High school	399	292	86	13	8
High school graduate	1253	981	228	21	12
< College	895	733	131	23	8
College graduate	650	571	60	14	5
Postgraduate	445	388	40	13	4
Census Region ^a					
Northwest	1048	822	187	31	8
Midwest	1036	822	179	20	15
South	1601	1273	276	38	14
West	978	860	77	32	9
Day of Week					
Weekday	3156	2552	489	77	38
Weekend	1507	1225	230	44	8

(continued)

Table 9-3. Number of Respondents Who Obtained Water From Public and Private Water Sources for General Household Use (continued)

	Total N	Public Water	Private Well	Other Source	DK
Season					
Winter	1264	983	224	42	15
Spring	1181	973	171	26	11
Summer	1275	1057	174	31	13
Falle	943	764	150	22	7
Asthma					
No	4287	3477	652	117	41
Yes	341	274	59	3	5
DK	35	26	8	1	--
Angina					
No	4500	3646	695	115	44
Yes	125	100	18	5	2
DK	38	31	6	1	--
Bronchitis / Emphysema					
No	4424	3582	683	115	44
Yes	203	167	30	4	2
DK	36	28	6	2	--

^a Composition of Census Regions is provided in Sec. 2.4.

Note: N = Number of respondents; DK = don't know; Refused = respondent refused to answer; -- = missing data.

Source: Tsang and Klepeis, 1996.

Table 9-4. Number of Respondents Who Use Bottled Water for Drinking Water in the Home

	Total N	Respondents					
		N	%	N	%	N	%
Overall	4663	2650	56.8	2006	43.0	7	0.2
Gender							
*	2	2	100.0	*	*	*	*
Male	2163	1241	57.4	918	42.4	4	*
Female	2498	1407	56.3	1088	43.6	3	*
Age (years)							
*	84	46	54.8	38	45.2	*	*
1-4	263	126	47.9	137	52.1	*	*
5-11	348	193	55.5	155	44.5	*	*
12-17	326	185	56.7	141	43.3	*	*
18-64	2972	1588	53.4	1380	46.4	4	0.1
> 64	670	512	76.4	155	23.1	3	0.4
Race / Ethnicity							
*	60	29	48.3	31	51.7	*	*
White	3774	2259	59.9	1508	40.0	7	0.2
Black	463	186	40.2	277	59.8	*	*
Asian	77	39	50.6	38	49.4	*	*
Some other	96	45	46.9	51	53.1	*	*
Hispanic	193	92	47.7	101	52.3	*	*
Hispanic							
*	46	22	47.8	24	52.2	*	*
No	4244	2438	57.5	1798	42.4	7	0.2
Yes	348	171	49.1	177	50.9	*	*
DK	26	19	73.1	7	26.9	*	*
Employment							
*	958	512	53.4	446	46.6	*	*
Full Time	2017	1062	52.7	952	47.2	3	0.1
Part Time	379	211	55.7	168	44.3	*	*
Not Employed	1309	865	66.1	440	33.6	4	0.3
Education							
High School	1021	552	54.1	469	45.9	*	*
High School	399	272	68.2	127	31.8	*	*
Graduate	1253	741	59.1	507	40.5	5	0.4
< College	895	485	54.2	409	45.7	1	0.1
College Graduate	650	354	54.5	296	45.5	*	*
Postgraduate	445	246	55.3	198	44.5	1	0.2
Census Region							
Northeast	1048	563	53.7	483	46.1	2	0.2
Midwest	1036	654	63.1	381	36.8	1	0.1
South	1601	916	57.2	682	42.6	3	0.2
West	978	517	52.9	460	47.0	1	0.1
Day of Week							
Weekday	3156	1775	56.2	1375	43.6	6	0.2
Weekend	1507	875	58.1	631	41.9	1	0.1

Table 9-4. Number of Respondents Who Use Bottled Water for Drinking Water in the Home
(continued)

	Total N	Respondents					
		N	%	N	%	N	%
Overall	4663	2650	56.8	2006	43.0	7	0.2
						(continued)	
Season							
Winter	1264	715	56.6	547	43.3	2	0.2
Spring	1181	671	56.8	508	43.0	2	0.2
Summer	1275	692	54.3	582	45.6	1	0.1
Fall	943	572	60.7	369	39.1	2	0.2
Asthma							
No	4287	2454	57.2	1826	42.6	7	0.2
Yes	341	180	52.8	161	47.2	*	*
DK	35	16	45.7	19	54.3	*	*
Angina							
No	4500	2542	56.5	1952	43.4	6	0.1
Yes	125	87	69.6	37	29.6	1	0.8
DK	38	21	55.3	17	44.7	*	*
Bronchitis / Emphysema							
No	4424	2518	56.9	1899	42.9	7	0.2
Yes	203	113	55.7	90	44.3	*	*
DK	36	19	52.8	17	47.2	*	*

Note: N = Number of respondents; * = missing data; DK = don't know.

Source: Tsang and Klepeis, 1996.

Table 9-5. Percentage of Mothers Breast Feeding Newborn Infants in the Hospital and Infants at 5 or 6 Months of Age in the U.S. in 1989^a by Ethnic Background and Selected Demographic Variables^b

Category	Total		White		Black		Hispanic ^c	
	Newborns	5-6 Mo Infants	Newborns	5-6 Mo Infants	Newborns	5-6 Mo Infants	Newborns	5-6 Mo Infants
All mothers	52.2	19.6	58.5	22.7	23.0	7.0	48.4	15.0
Parity								
Primiparous	52.6	16.6	58.3	18.9	23.1	5.9	49.9	13.2
Multiparous	51.7	22.7	58.7	26.8	23.0	7.9	47.2	16.5
Marital status								
Married	59.8	24.0	61.9	25.3	35.8	12.3	55.3	18.8
Unmarried	30.8	7.7	40.3	9.8	17.2	4.6	37.5	8.6
Maternal age								
< 20 yr	30.2	6.2	36.8	7.2	13.5	3.6	35.3	6.9
20-24 yr	45.2	12.7	50.8	14.5	19.4	4.7	46.9	12.6
25-29 yr	58.8	22.9	63.1	25.0	29.9	9.4	56.2	19.5
30-34 yr	65.5	31.4	70.1	34.8	35.4	13.6	57.6	23.4
≥35 yr	66.5	36.2	71.9	40.5	35.6	14.3	53.9	24.4
Maternal education								
No college	42.1	13.4	48.3	15.6	17.6	5.5	42.6	12.2
College ^d	70.7	31.1	74.7	34.1	41.1	12.2	66.5	23.4
Family income								
< \$7,000	28.8	7.9	36.7	9.4	14.5	4.3	35.3	10.3
\$7,000-\$14,999	44.0	13.5	49.0	15.2	23.5	7.3	47.2	13.0
\$15,000-\$24,999	54.7	20.4	57.7	22.3	31.7	8.7	52.6	16.5
≥\$25,000	66.3	27.6	67.8	28.7	42.8	14.5	65.4	23.0
Maternal employment								
Full time	50.8	10.2	54.8	10.8	30.6	6.9	50.4	9.5
Part time	59.4	23.0	63.8	25.5	26.0	6.6	59.4	17.7
Not employed	51.0	23.1	58.7	27.5	19.3	7.2	46.0	16.7
U.S. Census Region ^e								
New England	52.2	20.3	53.2	21.4	35.6	5.0	47.6	14.9
Middle Atlantic	47.4	18.4	52.4	21.8	30.6	9.7	41.4	10.8
East North Central	47.6	18.1	53.2	20.7	21.0	7.2	46.2	12.6
West North Central	55.9	19.9	58.2	20.7	27.7	7.9	50.8	22.8
South Atlantic	43.8	14.8	53.8	18.7	19.6	5.7	48.0	13.8
East South Central	37.9	12.4	45.1	15.0	14.2	3.7	23.5	5.0
West South Central	46.0	14.7	56.2	18.4	14.5	3.8	39.2	11.4
Mountain	70.2	30.4	74.9	33.0	31.5	11.0	53.9	18.2
Pacific	70.3	28.7	76.7	33.4	43.9	15.0	58.5	19.7

^a Mothers were surveyed when their infants were 6 months of age. Mothers were asked to recall the method of feeding the infant when in the hospital, at age 1 week, at months 1 through 5, and on the day preceding completion of the survey. Numbers in the columns labeled "5-6 Mo Infants" are an average of the 5-month and previous-day responses.

^b Based on data from Ross Laboratories.

^c Hispanic is not exclusive of white or black.

^d College includes all women who reported completing at least 1 year of college.

^e States within each census region are listed in text sec. 2.4.

Source: NAS, 1991.